On May 22d, the Club visited Williams' Bridge, and followed the course of the Bronx river southward. The persons present were Misses Dubois and Adam, and Messrs. Leggett, Britton, Wilber, Schoeny, Gross and Gerard. Here new stations were discovered for the following plants: *Staphylea trifolia*, L., *Allium tricoccum*, Ait., and *Galium Mollugo*, L., along R. R., south of depot; *Arisaema, Dracontium*, Schott, in a swamp near the Bronx river; and *Isoetes riparia*, Engelm., on the river shore about opposite Fordham station.

On May 29th, five members of the Club—Messrs. Rudkin, Bower, Britton, Schrenk and Schoeny—visited the pine barrens, and explored the region lying between New Egypt and Manchester, and afterwards proceeded to Tom's River. At New Egypt, *Viola tricolor*, L. var. *arvensis*, DC., was found in some abundance, and seemingly a native. *Anthemis arvensis*, L. was observed to be rapidly spreading and becoming very common in the "Pines."

On June 5th, the field meeting was held at New Dorp, S. I., Messrs. Rudkin, Bower, Britton and Gerard being present. No new plants nor no new stations were discovered on this excursion.

§ 57. The Geological History of the North American Flora,

by J. S. NEWBERRY.

[*Abstract of a lecture delivered before the Torrey Botanical Club.*]

America is called the New World, but, so far as we now know, that portion of North America which lies immediately north of the St. Lawrence and the Great Lakes, with its southern extension, the Adirondack region, is the oldest portion of the earth's surface. This land area, sometimes wider, sometimes narrower, and gradually increasing, has continued to exist throughout all recorded geological time; hence it is not surprising that we have here the most complete and connected history of plant life. A brief synopsis of this history I shall attempt to give you this evening.

Previous to the Cambrian and Silurian ages, and the beginning of the *legible* life-record of the globe, a broad continental area occupied what is now the eastern half of North America. Whether this land bore any terrestrial vegetation we do not yet know. The Archaean rocks which compose it contain quantities of carbonaceous matter, now graphite, undoubtedly derived from plant tissue; but whether the tissue of land plants or seaweeds we have no means of knowing, in consequence of the complete metamorphism of the strata.

In the Lower Silurian age this old continent sank, and the sea flowed in over a large part of its surface. The beach formed by this invading sea we now call the Potsdam sandstone. Later deposits, which are like this, the direct wash of the land, frequently contain the impressions of land plants in abundance. In the Potsdam sandstone we have found none, and therefore we may infer that, if not absent, they were few in this age. Marine plants however were abundant, and the layers of the Potsdam sandstone are in a thousand places covered thickly with a network of interlacing stems of seaweeds, or rather their casts, because the vegetable tissue has all disappeared.

The limestones of this age—the organic sediments spread by the Silurian ocean over all the area it submerged—contain also abund-

ant impressions of seaweeds, but no unequivocal traces of land vegetation. Some casts of plant stems found near Cincinnati have been described by Mr. Lesquereux as the remains of land plants, but in my judgment other proof of the existence of land vegetation in the Lower Silurian age must be furnished before we can make any positive assertion on the subject.

In the Upper Silurian age, narrower, but still extensive portions of our old continent suffered submergence, and in the deposits of this second sea we have indisputable evidence of the existence of land plants. These have been found in Michigan and Canada, and consist of the remains of ferns, lycopods, equiseta and conifers, but the specimens are small in size and comparatively few in number, and hence we may infer that land vegetation was not abundant. We are also warranted in the inference, since we have in this earliest known land flora the highest group of cryptogams—the acrogens, and the still higher gymnosperms—that this is not the real beginning of the land flora, and that something simpler and older existed and will probably be discovered. As before, there were seaweeds in great abundance in the Upper Silurian sea.

The subsidence which gave us the series of sediments we now call the Devonian system, was less extensive than those which took place before the area of permanent land was greater; and the proofs that this land was covered with a luxuriant, beautiful and varied terrestrial flora are conclusive. We have of course made but a beginning in the disinterment of the remains of this flora, but we have already learned enough of it to sketch in clear and strong lines its principal botanical features.

Dr. Dawson has described from the Devonian rocks of Canada and New York, more than a hundred species of Devonian fossil plants. These include conifers of several genera, ferns in considerable number, and not a few lycopods and equiseta. Within the United States the most interesting Devonian plants have been found in the Corniferous limestone of Ohio, and the Hamilton rocks of Gilboa, N. Y. In this age, a chain of islands ran down from Lake Erie to Tennessee, and, in the limestone which accumulated in the sea surrounding these islands, quite a large number of plant remains have been found. These seem to have been floated off from the Cincinnati island and water logged in the adjacent ocean. The trunks of tree-ferns representing three genera, with a number of smaller plants, have been already obtained from the insignificant excavations of the quarries at Delaware and Sandusky. At Gilboa we have the old shore upon which the plants grew, and here again we find tree ferns of several kinds, some of the trunks attaining a diameter of two feet, with *Nöggerathia*, supposed to be a cycad, *Lepidodendron*, a lycopod, and that singular *Psilophyton* of Dawson apparently connecting the lycopods and ferns, and widely diffused in the Devonian age.

The Carboniferous flora was but a continuation and expansion of the Devonian. It has been so fully revealed in our excavation of the coal beds, and has been so well studied, that all its general features have come to be familiar to every student of geology. No lengthy description of the coal flora, rich and interesting as it is, is therefore

required here. I will only say in passing that the Carboniferous flora of America exhibits the same botanical characters as that of the Old World. A few genera and a large number of species are peculiar to America, but in all the great collections of fossil plants gathered from the coal strata of this country, there is perhaps no botanical element which has not also been noticed in Europe. It is impossible now to say how many species of plants have been obtained from our American Carboniferous rocks, for the literature of the subject is cumbered with much synonymy, and species have been multiplied by describing under distinct names the stems, leaves, and fruit of the same plant ; but at least five hundred distinct species have been described, and that number is being added to every year. Of those already known, probably half should be considered identical with some of those found in Europe; and in some strongly marked and well-known species the identity is so complete that we cannot but wonder at the potency of the vital influence which held so closely to an elaborate pattern, organic structures inhabiting different quarters of the globe.

The Triassic and Jurassic floras were essentially alike in botanical characters. They both show a complete and surprising revolution in the vegetation of the globe in the passage from the Palaeozoic to the Mesozoic ages. By influences of which up to the present time we are ignorant, the great acrogenous flora of the Devonian and Carboniferous—consisting of gigantic lycopods and equiseta, the peculiar group of sigillarids, a few simple-leaved cycads, and many ferns—passed away "like a tale that is told" and, instead, without known transitional forms, arose the great cycadaceous flora of the Mesozoic. Here the lycopods have shrunk to insignificance, the sigillarids are extinct, the calamites with their allies, *Annularia* and *Sphenophyllum* are replaced by true *Equiseta*, the conifers and cycads multiplied until they constitute the most conspicuous forms of vegetation. These conifers were Araucarians; some with close rhomboidal appressed disks for leaves (*Brachyphyllum*), others with divergent fleshy scales (*Albertia*) like the Brazilian Araucaria of the present day, and still others with filiform foliage like the modern spruces (*Voltzia.*) The cycads were almost infinitely varied. Some were arborescent, with lofty trunks crowned with graceful canopies of nodding plume-like fronds, while others grew in spheroidal masses marked with rhombic leaf scars, suggesting to the first discoverer gigantic birds' nests (*Mantellia nidiformis*). Remarkable changes are also noticeable in the ferns. Those with highly compound fronds (*Sphenopteris*, *Pecopteris*, etc.), which existed in such vast numbers in the Carboniferous age, were to a great degree superseded by those with simple linear or spatulate fronds (*Taeniopteris*), and by those in which the stipe bore a horizontally-expanded pedate or spiral frond (*Camptopteris*, etc.) or broad pinnate or radiate fronds, like *Clathropteris*, of which the surface was divided into rectangular areoles by the strong nervation. All these forms were as unlike as possible to the ferns of the Palaeozoic ages, and had little resemblance to any that are now living.

Abundant remains of the Triassic flora are found in the rocks of this age at Richmond, North Carolina, in New Jersey, and in the Connecticut Valley. In certain localities vegetation was so luxuriant

that it accumulated in the form of extensive and thick beds of peat, which are now coal. Associated with these coal beds near Richmond, and in the Deep and Dan River basins of North Carolina, we have a full representation of the plants from which the carbonaceous matter was derived, and no stronger proof of the wide difference between the floras of the Carboniferous and Triassic ages could be afforded than by the comparison of the plants preserved in the roof shales of the coal beds of Virginia and Pennsylvania; the first being Triassic, the second Carboniferous.

A large number of Triassic plants have also been found at the old copper mines near Abiquin, New Mexico, and at Los Bronces, Sonora, all representing the same botanical groups, cycads in large variety (*Otozamites*, *Podozamites*, etc.), a preponderance of monophyllous ferns, with a few of the finer-cut species.

Of the *Jurassic flora* of North America very little is known. The Triassic plants are for the most part from the upper members of the series, or Rhaetic beds of the Old World; and it is quite possible that the colored marls and clays which are found about Baltimore, forming the summit of the Trias, should be regarded as Jurassic. They have yielded quite a number of plants, principally cycads and finely divided ferns, all of new species.

Cretaceous Flora.—Nowhere in the world up to the present time has there been found an angiospermous leaf in the Triassic or Jurassic rocks. In India, China, Europe, America, the flora of the Jura and Trias has the character I have already ascribed to it; but resting immediately upon these beds so full of cycads, conifers and ferns we find in New Jersey, and in innumerable localities in the far West, the Lower Cretaceous sandstones and clays, full of the remains of plants, and these altogether unlike those which had gone before.

From causes which we cannot as yet understand, nor even conjecture, the vegetation of the world was at this period of its history more completely revolutionized than at any previous epoch; for here came in the angiosperms, by no transition indicated in the record, but by a sudden irruption. At the beginning of the Cretaceous age they seem to have spread over the earth's surface, and soon became the predominant and characteristic forms of vegetation, giving to Nature the aspect which she now exhibits.

In the Lower Cretaceous clays of New Jersey, and their equivalents, the Dakota group of the far West, the representatives of the Middle Cretaceous strata of the Old World, the remains of at least one hundred distinct species of angiospermous arborescent plants have already been found. With them are many conifers of Araucarian affinities, and fan palms like those of the present day; but the forests that covered the continent when the Cretaceous sea invaded it consisted mostly of oaks, willows, sassafrases, magnolias, tulip trees, sweet gums—the genera most abundant in our living forests. Here, then, we have according to the present state of our knowledge the beginning of our modern flora. As to where it originated, and by what influence it was developed, we as yet have no information; but inasmuch as a long period of time is probably represented by the line which divides our Triassic or Jurassic and Cretaceous rocks, an inter-

val in which the lowest members of the Cretaceous series were accumulating in the Old World, it is evident that we must go elsewhere to find the record of the gradual substitution of the angiospermous flora of the Chalk for the cycadaceous vegetation of the Trias and Jura.

In the studies that have been made of the foreign Cretaceous flora it is said that the change was gradual; first, a few angiosperms mingled with the predominating cycads and ferns; and subsequently, the angiosperms becoming more numerous. But it is also stated that no transitorial forms mark the passage from one flora to the other.

Descriptions of some of the Cretaceous plants of the far West were published in 1869 by myself, in a paper on our later extinct floras, which appeared in the *Annals of the N. Y. Lyceum of Natural History*. More recently a much larger number have been described by Mr. Lesquereux in one of the series of Dr. Hayden's Reports, devoted entirely to the Cretaceous flora.

Within the past year we have begun to open an herbarium of fossil plants in the Cretaceous beds of New Jersey, which promises to give us a more accurate knowledge of this flora than has been obtained from any other source. A large number of angiosperms and conifers have already been obtained from these beds, and Mr. Britton of this Society, will spend the coming summer in making further collections from the clays and sands along the Raritan River, so that when we meet again in the autumn I shall hope to be able to report some interesting results of this investigation.

Of the herbaceous and humbler elements of the Cretaceous flora we have as yet little knowledge, but the Cretaceous forest stands before us in well-defined characters. We rather pride ourselves now on the variety, beauty and majesty of our forest trees, but we have reason to believe that the forests of the Cretaceous included at least as large a number of species, and perhaps as imposing and beautiful individuals as those of the present day.

Since the Cretaceous flora consists of so many of the genera now growing in our climate, we must conclude that the climate which prevailed during the Cretaceous, within the area of our possessions, was also temperate, and that the theory somewhat widely promulgated that our flora began in the Arctic regions and spread south with the gradual decrease in temperature is without foundation in facts.

Tertiary Flora.—The flora of North America during the Tertiary ages seems to have been but a continuation of that of the Cretaceous. Many new genera and species were added, and a number of the latter are still in existence, but the botanical aspect of the flora was similar to that prevailing both before and after. During the Tertiary a mild climate extended over the entire North American continent, and as we know by the abundant remains of plants discovered in Alaska on Mackenzie's River, Disco Island and Greenland, a luxuriant flora similar in character to that of our Middle and Southern States was spread all along the northern sea-board. The remains of the living deciduous cypress, *Taxodium distychum*, have been found in nearly all the Tertiary deposits explored, even as far north as Greenland. The northern range of this species is now about the 36° of latitude, from which we may infer that the average annual temperature of the entire conti-

nent in the Tertiary age was above 50° Fahr. During this period there was a land connection between North America and Europe by way of Iceland and the Hebrides, and also with the Asiatic continent by way of Behring Strait. Taking advantage of this opportunity our American flora seems to have marched over and occupied both these continents. In Southern Europe the climate at the beginning of the Tertiary was sub-tropical, and the Indian Ocean communicated with the Atlantic through the Mediterranean. The gradual elevation of the Alps, Pyrenees, etc., during the Tertiary age, resulted in the formation of a barrier which limited the reach of austral influences and gave a temperate climate to the interior of Europe. At this time the American temperate flora descended from the north and occupied all Europe ; for we find in the Miocene or Middle Tertiary strata the remains of the deciduous cypress, our magnolias, the tulip tree, sweet gum, sassafras and the American poplars. When the Ice period came on, however, these plants were driven southward but found their retreat cut off by the Mediterranean, and were thus mostly exterminated. Subsequently, when a milder climate supervened, the vacant area thus formed was entered and possessed by a flora for the most part of Asiatic origin. In Japan and China, however, our American flora still exists. There is a remarkable similarity between the flora of Japan and that of Eastern America ; many of the species being identical, and others so closely allied that they must have had a common origin. We find, too, in China and Japan some interesting members of our American Tertiary flora, which, once common here, have been by some cause exterminated, while they still exist in Asia. Of these, perhaps the most striking examples are the *Salisburia* or ginko, a genus well represented in our Cretaceous and Tertiary flora, and the *Glyptostrobus*, another conifer which was abundant both in Europe and America in the Tertiary age, but, disappearing elsewhere, has survived in China.

I have said that our Tertiary flora was directly derived from the Cretaceous, and was the distinct progenitor of that of the present day. This is strictly true; but, if we may judge by the arborescent plants, our living flora is but a wreck and relic of that which covered our continent before the Ice period. We have already collected from the Tertiary strata in various parts of the country the remains of more species of forest trees than are now growing on its surface, and yet every year sees important additions made to the list. Imperfect as is the picture which these fragmentary fossils give us of the Tertiary flora, we find in it an explanation of some facts in the flora of the present day which have long puzzled botanists. For example, our giant trees, the two Sequoias of California, though of enormous size, are confined to very narrow geographical limits, the mammoth tree being restricted to a few groves ; so in our eastern forests the sassafras, the sweet gum, and the tulip tree are each a solitary representative of its genus, and it has been a matter of surprise that these noble and striking trees should have no living relatives ; but as we turn the pages of the Tertiary herbarium we find each of these genera represented by many species, and the species now living and restricted to narrow bounds, then having a very extended range, and existing in count-

less numbers. We find, too, that we have lost many of the grandest elements in the Tertiary flora ; for example, our sycamores (*Platanus occidentalis*, and *P. racemosus*,) were in Tertiary times represented by a half dozen species which are now extinct, and of these, two at least would seem to have surpassed in magnitude and beauty our common one, great and grand as it is; for I have leaves of two extinct sycamores that are each one and a half feet in diameter. Camphor trees, palms, and figs were also features in our Tertiary flora which exist no longer outside of the tropics.

The most potent influence which operated to change the flora of the Tertiary to that of the present day was undoubtedly the cold of the Ice period. Although less destructive here than in Europe, because the southern extension of our continent offered a place of retreat before the advancing ice-sheet, the substitution of an Arctic climate for the mild temperature which prevailed in Tertiary times throughout the northern portion of the continent, and the spread of unbroken fields of snow and ice over all the surface north of the fortieth parallel, caused the destruction of all plant life over three-fourths of the area covered with the luxuriant growth of the Tertiary vegetation. It also forced the remnant into such narrow quarters that vast numbers of species were exterminated, and left the flora in the fragmentary condition it now exhibits. The effect upon the fauna was still more disastrous, for a forest tree needs no greater space than is occupied by its roots in the earth and its branches in the air, while the surface required for the support of one of the larger mammals is much greater. Hence of the grand Tertiary fauna scarce a remnant survived, while of the plants, when better days returned, and the snow fields and ice-sheets retreated to Greenland, a sufficient number came back from their banishment to cover the central portion of the continent with a flora which retained all the essential botanical characters of that of the Tertiary, but the vicissitudes through which it had passed had told sadly upon it. Many of its grandest and most beautiful elements had disappeared forever, while a few of its magnolias, tulip trees, sequoias and liquidambars survive as solitary representatives of the groups to which they once belonged, and form groves instead of boundless forests. Overtopping in their grandeur, or outshining in their beauty, their present associates, they attest the general magnificence of those ancient forests that were composed of their progenitors and extinct relatives, their equal or superiors.

§ 58. **Adiantum Capillus-Veneris,** L., in Kentucky.—On the 28th of last month I received the following letter from Mr. Linney, containing a small piece of this fern.

Harrodsburg, Ky.

"DEAR W.—Mr. E. H. Gaither of this place found last week under a cascade, ½ mile from Burnside's Point, Pulaski Co., great quantities of *A. Capillus-Veneris*, if that is this form. Yours,

W. M. LINNEY."

I at once wrote to Mr. Linney to send me the best specimen he could get from Mr. Gaither, and to give me all the particulars about the locality. He sent me four very good plants, two of them measuring